

### **REMARKS**

Claims 6, 9 and 12 are amended herein. Support for the amendment to Claim 6 is found in the specification, for example, at page 9, first paragraph. Support for the amendment to Claims 9 and 12 is found in the specification, for example, at the paragraph bridging pages 14-15, and at page 18, third full paragraph. The amendments do not add new matter.

New Claim 14 is added herein. Support for new Claim 14 is found in the specification, for example, at page 9, first paragraph. New Claim 14 does not add new matter.

Upon entry of the amendment, Claims 6-12 and 14 are under examination.

### **Restriction Requirement and Election**

The claims of the present application have been subject to a restriction requirement restricting the claims into two groups:

Group I, Claims 1-5 and 13; and

Group II, Claims 6-12.

Applicants orally elected Group II, Claims 6-12. Applicants hereby affirm the election, and confirm that this election is made without traverse.

### **Rejection of Claims 6-8 under 35 U.S.C. §102(e)**

Claims 6-8 are rejected under 35 U.S.C. §102(e) as being anticipated by Sun (US Pat. 6,676,729). The Office Action states that Sun, at column 5, lines 25-30, discloses a process having all elements of the claims.

Claim 6 is directed to a method for manufacturing metal nanoparticles by heat-treating a starting material containing a metal salt, in the presence of an amine compound and in an inert gas atmosphere, without use of an organic solvent. Sun does not disclose manufacturing metal nanoparticles without use of an organic solvent. Accordingly, Sun cannot anticipate the method of Claim 6 or any claim dependent therefrom.

When heat treatment is performed using an organic solvent, such as performed in the method of Sun, the formed core metal and protecting groups are diluted by the organic solvent. That is, the core metal and protecting groups are dilute, which diminishes their interactions with one another. In contrast, the presently claimed method is carried out at a high concentration

because no organic solvent is used. This results in the protecting groups being present at a high concentration in the vicinity of the core metal, which thereby suppresses the agglomeration that accompanies the growth of particles in traditional methods. The presently claimed invention therefore makes it possible to manufacture metal nanoparticles with excellent dispersion stability and a small average particle diameter.

Sun discloses in column 5, lines 25-30, that platinum acetylacetonate,  $\text{FeCl}_2$ , 1,2-hexadecanediol, and phenyl ether are heated under nitrogen, and then oleic acid and oleylamine are added. However, it is essential in Sun to mix the metal complex with a solvent; that is, the use of a solvent is necessary to the method of Sun. *See, e.g., Sun* at Abstract, Claim 1, figure on face of patent. Further, Sun emphasizes the importance of the solvent by mandating that the metal salts used must be soluble in the solvent:

The metal salts employed must be at least partially soluble in the solvent, and the reductions are carried out under an inert atmosphere, as the neutral metal species are often very air sensitive. *Sun* at column 4, lines 53-62.

Thus, Sun emphasizes the importance of the solvent in terms of the solvent's relationship with the metal salts employed. Accordingly, it would be contrary to the teachings of Sun to avoid using an organic solvent in manufacturing metal nanoparticles. Therefore, Sun does not teach heat treatment of a metal complex "without use of an organic solvent" as recited in Claims 6-8 and 14 of this application. Moreover, Sun does not teach the superior effects of heat treatment of a metal complex "without use of an organic solvent" as described above. As such, the presently claimed methods are both novel and non-obvious over the method of Sun.

#### **New Claim 14 is Further Novel over Sun**

New Claim 14 is directed to the method of Claim 6, wherein the amine and the starting material containing the metal component is heat-treated while still solid. New Claim 14 is novel over Sun because Sun does not disclose a method where the starting material containing the metal component is heat-treated while still solid. Accordingly new Claim 14 contains further elements not disclosed by Sun. As such, Claim 14 is further novel over Sun.

#### **Rejection of Claims 9, 11 and 12 under 35 U.S.C. §102(b)**

Claims 9, 11 and 12 are rejected under 35 U.S.C. §102(b) as being anticipated by Heineke (US Pat. 6,197,720) or Murray (US Pat. 6,262,129). The Office Action points to Heineke's

Example 1 and Murray's column 3, lines 13-20 and column 4, lines 29-37, as disclosing processes having all elements of the claims.

Claim 9 is directed to a method for manufacturing metal nanoparticles by heating treating in an inert gas atmosphere a metal complex having a phosphine ligand and a carboxylate ligand, while the metal complex is still a solid. Neither Heineke nor Murray discloses manufacturing metal nanoparticles while the metal complex is still a solid. Accordingly, Heineke and Murray cannot anticipate the method of Claim 9 or any claim dependent therefrom.

Claim 12 is directed to a method for manufacturing metal nanoparticles which comprises a step of heat-treating a mixture containing (1) phosphine and (2) (i) a metal salt of a fatty acid or (ii) a fatty acid and a metal salt in an inert gas atmosphere, while the mixture is still a solid. Neither Heineke nor Murray discloses manufacturing metal nanoparticles while the mixture is still a solid. Accordingly, Heineke and Murray cannot anticipate the method of Claim 12.

Applicants note that in Claim 9, the expression "while the metal complex is still a solid" refers to the metal complex being in a solid state when subjected to heat treatment. By this language, the metal complex is not required to be constantly in a solid state, but can be substantially thermally melted and decomposed during the process of the heat treatment. The same applies to the phrases "while the mixture is still a solid" in Claim 12.

When heat treatment is performed with the metal salt or metal complex being taken up in solute form, such as performed in the methods of Heineke and Murray, the formed core metal and protecting groups are diluted as a result of the dissolution. That is, the core metal and protecting groups are dilute, which diminishes their interactions with one another. In contrast, the presently claimed methods are carried out at high concentrations because the solid form is substantially thermally melted and decomposed during the process of the heat treatment, without the requirement for solvent. This results in the protecting groups being present at a high concentration in the vicinity of the core metal, which thereby suppresses the agglomeration that accompanies the growth of particles in traditional methods. The presently claimed invention therefore makes it possible to manufacture metal nanoparticles with excellent dispersion stability and a small average particle diameter.

Example 1 of Heineke discloses that palladium (II) acetate and triphenylphosphine are dissolved in 3-methylbutanol and heated under nitrogen. However, Heineke does not teach

heating a metal complex “while ... still a solid,” since the palladium (II) acetate is mixed with triphenylphosphine in a solvent (3-methylbutanol), and heated. It is essential in Heineke to dissolve the palladium complex in a solvent; that is, the use of the palladium complex in solution is necessary to the method of Heineke. *See, e.g., Heineke* at column 2, lines 30-38. Further, Heineke teaches use of a solution containing palladium salt as the generalized method provided by Heineke:

The palladium salt is reacted with the reducing agent in general by stirring a solution containing the palladium salt, with or without another metal salt, the protective ligand and the reducing agent at from 0 to 300.degree. C., preferably 20 to 80°C, particularly preferably 50 to 70°C, for a period of a few minutes up to some days, preferably 2 to 10 days, particularly preferably 2 to 7 days. *Heineke* at column 4, lines 27-33.

Thus, Heineke teaches that the generalized method for Heineke’s method involves reacting a solution containing palladium salt with a reducing agent. As such, Heineke makes clear that the palladium salt in solution form is integral to Heineke’s method. Accordingly, it would be contrary to the teachings of Heineke to avoid using palladium salt in solution form in manufacturing metal nanoparticles. Therefore, Heineke does not teach heat treatment of a metal complex “while .. still a solid” as recited in Claims 9 and 12 of this application. Moreover, Heineke does not teach the superior effects of heat treatment of a metal complex “while ... still a solid” as described above. As such, the presently claimed method is both novel and non-obvious over the method of Heineke.

Example 1 of Murray discloses that cobalt acetate tetrahydrate, oleic acid,  $\text{PR}_3$  (phosphine), and phenyl ether are heated under nitrogen. However, Murray does not teach heating a metal complex “while ... still a solid,” since the cobalt acetate tetrahydrate is mixed with a phosphine compound in a solvent (phenylether), and heated. It is essential in Murray to dissolve the metal salt in a solvent; that is, the use of the metal salt in solution is necessary to the method of Murray. *See, e.g., Murray* at at Abstract, Claim 1, and Figures 15 and 16. Further, Murray emphasizes the importance of the solvent in Murray’s methods:

More specifically, a method of forming nanoparticles, includes steps of: forming a metal precursor solution from a transition metal; introducing the metal precursor solution to a surfactant solution; adding a flocculent to cause nanoparticles to precipitate out of solution without permanent agglomeration; and adding a hydrocarbon solvent for one of redispersing and reprecipitating the nanoparticles.

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Thus, as described above, the present invention achieves solution phase, high temperature reduction of metal salts and decomposition of neutral organometallic precursors which lead to metal nanoparticles. *Murray* at column 3, lines 6-12 and column 11, lines 49-52.

Thus, *Murray* teaches that *Murray*'s method involves forming nanoparticles by first forming a solution containing metal salt. As such, *Murray* makes clear that the metal salt being in solution form is integral to *Murray*'s method. Accordingly, it would be contrary to the teachings of *Murray* to avoid using metal salt in solution form in manufacturing metal nanoparticles. Therefore, *Murray* does not teach heat treatment of a metal complex "while .. still a solid" as recited in Claims 9 and 12 of this application. Moreover, *Murray* does not teach the superior effects of heat treatment of a metal complex "while ... still a solid" as described above. As such, the presently claimed method is both novel and non-obvious over the method of *Murray*.

#### **Rejection of Claim 10 under 35 U.S.C. §102(b) or 35 U.S.C. §103**

Claim 10 is rejected under 35 U.S.C. §102(b) as being anticipated by, or, in the alternative, under 35 U.S.C. §103 as being obvious over, Heineke (US Pat. 6,197,720) or *Murray* (US Pat. 6,262,129). The Office Action states that neither reference specifies the weight loss of the metal complex, but it would be reasonable to assume that Heineke's method and *Murray*'s method show an amount of weight loss within the claimed range. The Office Action states that alternatively, the amount of weight loss within the claimed range would have been an obvious optimization of Heineke or *Murray*.

Claim 10 depends from Claim 9. As Applicants have stated above, Claim 9 is not anticipated by or obvious over, the teachings of Heineke or *Murray*. As such, Claim 10 is novel and non-obvious over the references for at least those reasons provided above in regard to Claim 9.

#### **Provisional Obviousness-Type Double Patenting Rejection**

Claims 6-8 are provisionally rejected on the ground of obviousness-type double patenting as being unpatentable over Claims 5-9 of copending Application No. 10/591,708.

**Application No.:** 10/522,941  
**Filing Date:** August 31, 2005

The claims of the present application are not yet indicated as otherwise allowable. Applicants will file, if appropriate, a Terminal Disclaimer, upon determination of otherwise allowable subject matter in the present application.

*No Disclaimers or Disavowals*

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, the Applicants are not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. The Applicants reserve the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that the Applicants have made any disclaimers or disavowals of any subject matter supported by the present application.

**CONCLUSION**

In view of the above, Applicants respectfully maintain that claims are patentable and request that they be passed to issue. Applicants invite the Examiner to call the undersigned if any remaining issues might be resolved by telephone.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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